

UNIVERSITY OF WISCONSIN SYSTEM

The University of Wisconsin System (UWS) has research, teaching, and outreach responsibilities. These three missions are integrated through cooperation and joint appointments of teaching, research, and Extension personnel who work on groundwater issues. UWS staff members work with state and federal agencies and with other partners to solve groundwater resource issues. Citizen outreach is accomplished through publications, video and audio podcasts, social media, media relations, public meetings and presentations, teleconferences, and water testing and satellite programs. Activities of several specific programs are described below.

FY 2016 Highlights

- Funded a project to more actively involve citizens and stakeholders in water-use decisions
- Assembled a traveling photography display highlighting the state's wealth of water that has traveled to 14 venues this reporting period.
- Created all-inclusive kits for children in pre-K to fourth grade to teach age-appropriate STEM concepts with a water theme that are booked out for months into the future.
- Researchers leveraged a WRI project on manganese for NSF funding and a student originally funded on this WRI project was also awarded a NSF fellowship

Details of Ongoing Activities

The UW Water Resources Institute (WRI)

The UW Water Resources Institute (WRI) is one of 54 water resources institutes located at Land Grant universities across the nation with core funding provided and administered by the U.S. Department of the Interior through the U.S. Geological Survey. It promotes research, training, and information dissemination focused on Wisconsin's and the nation's water resources problems.

Research

The WRI research portfolio includes interdisciplinary projects in four broad areas: groundwater, surface water, groundwater-surface water interactions, and drinking water. Groundwater is a top priority and an area of particular strength at the WRI. Key areas of emphasis in FY15 included hydrology and research focused on geothermal heat exchange, groundwater-surface water interactions and various groundwater contaminants, including manganese and viruses.

During FY16 (July 1, 2015–June 30, 2016), the WRI directed a wide-ranging program of priority groundwater research consisting of five new projects and three continuation projects. These included short- and long-term studies both applied and fundamental in nature. They provide a balanced program of laboratory, field, and computer-modeling studies and applications aimed at preserving or



Researches recently leveraged the results of a WRI-funded project to win an NSF grant. The student (Sara Balgooyen, pictured here) who was funded by WRI separately received an NSF fellowship as well. *Photo: UW WRI.*

improving groundwater quality. These eight projects, funded by the UWS, provided training in several disciplines for several graduate student research assistants and undergraduate students at UW-Madison and UW-Milwaukee. Groundwater issues investigated during the past year included:

- Assessment of environmental impacts of geothermal source heat exchangers
- Hydrologic impacts of the loss of Wisconsin's winter on surface water - groundwater interactions
- Effect of source chemistry on Mn-bearing solid dissolution and reactivity in municipal water systems
- The Wonewoc and Tunnel City: A Potential Natural Source of Groundwater Contamination in Western & Central Wisconsin
- Long-term Alterations in Groundwater Chemistry Induced by Municipal Well Pumping
- Phosphorus & Arsenic Sensors for Real Time Environmental Monitoring
- Engaging Stakeholders to Improve the Use of Groundwater Flow Models for Decision Making
- Predicting the locations of nitrate removal hotspots at the groundwater-surface water interface in Wisconsin streams

For FY17 (July 1, 2016–June 30, 2017), the UWS selected three new groundwater research projects from proposals submitted in response to the Joint Solicitation and will continue four projects selected from the previous year's solicitation. The projects are based at University of Wisconsin-Milwaukee, University of Wisconsin-Stevens Point, University of Wisconsin-Madison, University of Wisconsin-Extension, and University of Wisconsin-Oshkosh, and include:

- Anthropogenically driven changes to the metagenome of a shallow groundwater and its effect on aquifer reactivity (new project)
- Investigating the impact of nitrate-nitrogen contamination on uranium concentrations in Wisconsin groundwater (new project)
- Geologic sources of radium to municipal wells in Wisconsin (new project)
- Long-term alterations in groundwater chemistry induced by municipal well pumping (continued project)
- Phosphorus and arsenic sensors for real-time environmental monitoring (continued project)
- Engaging stakeholders to improve the use of groundwater flow models for decision making (continued project)
- Predicting the locations of nitrate removal hotspots at the groundwater-surface water interface in Wisconsin streams (continued project)

Beginning with FY11, the WRI's annual 104(B) allocation was used to expand the scope of the Joint Solicitation to include research on the effects of a changing climate on Wisconsin's water resources. Priorities for research were established through a partnership with the Wisconsin Initiative on Climate Change Impacts (WICCI). Established in 2007, WICCI is a university-state partnership created to:(a) assess and anticipate the effects of climate change on specific Wisconsin natural resources, ecosystems,

and regions; (b) evaluate potential effects on industry, agriculture, tourism, and other human activities; and (c) develop and recommend adaptation strategies that can be implemented by businesses, farmers, public health officials, municipalities, resource managers, and other stakeholders. Two projects received continuation funding during FY16 and included:

- Establishing the Long-Term Range of Variability in Drought Conditions for Southwest Wisconsin
- Impacts of Climatic and Land Use Changes on Streamflow and Water Quality in the Milwaukee River Basin

Additionally, a portion of WRI's FY15 and 16 annual federal 104 (B) allocation was used to plan and conduct a workshop to advance the monitoring and analysis of trace metals and address applications in the upper Great Lakes. In FY16, funding was allocated to establish a new Wisconsin Water Resources Fellowship to fund a student project assistant to work half time at the Wisconsin Department of Natural Resources Bureau of Drinking and Groundwater. In FY17, this funding will be matched by DNR's Bureau of Water Quality for a full time postdoctoral fellow.

Teaching

Institutions within the UWS continue to offer undergraduate- and graduate-level courses and programs focusing on diverse issues regarding groundwater resources. Additionally, several campuses offer for-credit, field-oriented water curriculum courses for middle- and high-school teachers during summer sessions. The WRI views continuing education for P-12 teachers as an important component of its outreach and training effort. The Wisconsin Water Library, housed on the UW-Madison campus and a service of the WRI, maintains an extensive curriculum collection of guides with innovative approaches and other educational materials for teaching water-related science in P-12 classrooms. The curricula are available for checkout by all teachers and residents in Wisconsin. The librarian also has extensive experience in working with Pre-K children. She put that experience to use in developing already field-tested science, technology, engineering, art, and math curriculum kits. The kits will eventually number 27 on topics such as the water cycle, art and water, and pond science. In this reporting period, kits on buoyancy and on ponds were completed and joined one related to frogs. The kits contain several books, tips on a guided water-science experiment, and other themed activities. Finally, the library also provides checkout of an aquatic invasive species elementary- and middle-school-aged curriculum collection known as an attack pack. In this reporting period, five packs have been checked out 23 times to formal and nonformal educators (the maximum checkout period is two months), reaching approximately 1,135 students. The packs have been used to educate people about aquatic invasive species in the waters of Wisconsin. What is also unique about this tool is that in the past it was a problem to circulate packs designed like this. Now, the WRI has devised a distribution system through the public interlibrary loan system.

Grants Administration

WRI conducts the annual outside peer-review of proposals submitted to the State of Wisconsin Joint Solicitation for Groundwater Research and Monitoring (WGRMP). A website called [*iPROPOSE*](#) was developed by WRI staff members in FY07-09. The website enables seamless online submission and review of proposals. At the site, prospective investigators submit a proposal by filling out a series of forms and uploading their full proposal and budget. Assigned reviewers then complete their reviews through *iPROPOSE* by answering a series of questions online. Once all of the reviews are completed, the

UW Groundwater Research Advisory Council is given access to anonymous reviews and original proposals to help decide which proposals to recommend for funding. The website provides a framework for consistently capturing the same information from all of the prospective investigators and reviewers, thus helping to ensure that each proposal is treated equally.

Information and Outreach Activities

The [University of Wisconsin Water Resources Institute website](#) is a portal to information about WRI research projects and publications. One of the site's main audiences is researchers. To that end, the site provides a clear navigational path to the WRI project listings, project reports, a groundwater research data base, funding opportunities and conference information sections. The site is also integrated with the UW Aquatic Sciences Center's interactive [Project Reporting Online](#) system, an online tool that allows principal investigators to report on the progress of their projects. All of these areas are updated on a regular basis to ensure currency of information transfer. In this reporting period, the WRI website received an estimated 50,550 visitors. Additionally, WRI has a presence on Twitter, Facebook, Tumblr, Pinterest, Sound Cloud and Flickr.

WRI's video catalog includes "What is a spring?," "Streams neutralize nitrates in groundwater," "A new measure of groundwater flow," "Got oaks" and one of the most popular videos on the [YouTube channel](#), "Testing well water for microorganisms." To date it has nearly 9,500 views, which is a large number for a scientific topic. Additionally, WRI continued work on a video to explain Wisconsin's Groundwater-Level Monitoring Network, partnering with the Wisconsin Geological and Natural History Survey.

The program is also reaching audiences through an informative and entertaining seven-part audio podcast about mercury in aquatic environments. The series is offered through the WRI site, as well as through the University of Wisconsin-Madison iTunes university site. At the iTunes university site, WRI has been able to claim an artist's page. Pages such as these are reserved only for those who provide a deep array of content. The special pages allow a richer display of water-related content. Moreover, they provide a so-called "sticky" experience where users are attracted to the page for a specific need, but then stick around for additional, related information. "Aquifers and Watersheds" is a second podcast series. It demystifies these geological formations and the geoscience involved in studying them for the general public. It features eight chapters. Finally, this reporting period saw the initiation of a new audio podcast series that will be completed in early FY17. The series is called Undercurrents: The Hidden Knowledge of Groundwater.

During this reporting period, WRI staff were also integral to the content-population of <http://www.water.wisc.edu>. The site is a portal to the breadth and depth of water-related work on the state's flagship campus, the University of Wisconsin-Madison, and serves as the first stop for anyone interested in water research. Additionally, graduate students can search for departments offering courses and degrees that fit their interests, and staff and faculty can search for colleagues working on topics complementary to their own to facilitate greater interdisciplinary collaboration and exploration. The site had an estimated 44,850 visitors in this reporting period.

Water Resources Publications

The program offers easily accessible publications through an online store with free information or information available for a nominal cost. Topics include nitrates in groundwater, siting rain gardens, and arsenic. The program also produces the "[Aquatic Sciences Chronicle](#)" on a quarterly basis. It circulates to

roughly 5,700 online and print subscribers with an interest in WRI projects and related topics. The newsletters are also posted online. There were nearly 40,000 online visitors to the newsletter.

Traveling Photography Exhibit

Photography is a powerful way to communicate and in this reporting period, WRI coordinated a traveling photography exhibit along with its sister organization, the University of Wisconsin Sea Grant Institute. Four 24" x 36" double-sided panels depict stunning scenes of Wisconsin's water assets and highlight work that WRI and Sea Grant are doing to promote their sustainable use. The exhibit has traveled to public libraries in all corners of the state, with more visits scheduled for the remainder of 2016. At each stop, a news release is distributed to local media and local residents are invited to view the exhibit. There are also accompanying handouts to encourage further interaction through websites and tools such as the aquatic invasive species attack pack. WRI staff are offered as speakers for events in conjunction with the exhibit's run at a specific venue. In this reporting period, there were six presentations that resulted from the photography exhibit and included stops in Port Washington, Delavan, Palmyra, Middleton, Neenah and New Berlin. The display itself has been warmly received. At the conclusion of each month's installment, an evaluation is solicited and comments are consistently positive.



One of the traveling photo displays that has made its way to libraries, nature centers, and conferences across the state. *Photo: UW Sea Grant Institute.*

AWRA Annual Conference

The WRI was once again integral to the planning and staging of the American Water Resources Association-Wisconsin Section's annual conference. The theme of the 40th conference was 40 Years of Wisconsin Waters: Quantity, Quality, Technology. General areas covered included groundwater modeling, water quality, and agricultural hydrology, and management. The Wisconsin Section is also dedicated to mentoring future leaders in water resources and offers a student workshop and an opportunity for students to showcase their academic work. The meeting was supported by other academic and governmental partners, including the American Water Resources Association, Wisconsin Section; Center for Watershed Science and Education, UW-Stevens Point Wisconsin; Department of Natural Resources; U.S. Geological Survey, Wisconsin Water Science Center; and Wisconsin Geological and Natural History Survey.

Wisconsin's Water Library Outreach Activities

Wisconsin's Water Library is a unique resource for Wisconsin citizens. It contains more than 30,000 volumes of water-related information about the Great Lakes and the waters of Wisconsin. The library includes a curriculum collection, dozens of educational videos, a children's collection, and more than five journals, and 30 newsletters. In the reporting period, about 1,400 publications circulated among interested users.

In addition to archival benefits, the library provides outreach by answering many in-depth reference questions on a wide range of water-related topics. In partnership with the Wisconsin Department of

Natural Resources and the Wisconsin Wastewater Operator's Association (WWOA), the library continued its outreach to current and future wastewater and drinking water operators of Wisconsin. The library catalogs the essential technical manuals and loans them to WWOA members around the state in support of required state license examinations as well as in support of the educational needs of daily work. In this reporting period, 32 individuals used this material.

Wisconsin's Water Library continues to catalog all groundwater research reports from projects funded by the Water Resources Institute into WorldCat and MadCat, two library indexing tools that provide both worldwide and statewide access to WRI research. By having this information permanently indexed, the research results are easily available to other scientists throughout the University of Wisconsin System as well as across the nation and the world.

The library also maintains a digital archive of the entire collection of [Groundwater Research and Monitoring Program reports](#). The archive was created in partnership with the UW Digital Collections Center, and ensures a permanent and accessible electronic record of Wisconsin groundwater-related activities since 1984. Paper copies of the reports continue to be a part of the Wisconsin Water Library.

The library is also working to digitize and make more readily available the scripts and some audio from EarthWatch radio. The program was syndicated to more than 100 radio stations around the country in the latter half of the last century to make water science more accessible to broad audiences.

To build water literacy, staff reached approximately 309 Wisconsin residents through eight events conducted at public libraries, Head Start and other early-childhood programs, or as part of other informal learning setups. Library staff also delivered presentations to Head Start and environmental education instructors. This sparked inquiries from 14 teachers from around the state interested in STEM literacy. It demonstrates multiplier effect, that is, if each teacher reached a minimum of 10 students or lifelong learners that is nearly 150 people receiving STEM messages.

Library Websites

The library maintains several information transfer tools to reach library patrons and the most frequently accessed is the [library's robust website](#). The library's site serves as an outreach tool for those who want to know more about the state's water resources. It is currently being redesigned and is expected to launch early in the next reporting period. During the past 12 months, the library site had about 186,750 visitors.

In addition to its website, Wisconsin's Water Library uses other technology tools to reach library patrons. Using email, the library sends out a bimonthly *Recent Acquisitions List* to about 600 contacts. The message also includes recent updates to the library website and contact information for users to ask any water-related question. The library also supports an email at askwater@aquawisc.edu, which is monitored daily. Anyone with a water-related query can pose a question and receive a response in a timely manner. Some examples from the past year include, a boat owner inquired about what the best management practices are if the boat is infested with invasive zebra mussels, a student inquired about the diet, behavior and biology of invasive Asian carp, and a patron requested data to support groundwater monitoring.

The library has been using social media tools to reach new library users and to raise visibility of the library. The library has a blog, [AquaLog](#), where library staff reports on news, publications, and resources about water and the Great Lakes. The library is also using social media tools, Facebook and Twitter. Users of both technologies can become followers of both and get the latest on water-related information

instantly. [Facebook](#) is used often to announce events and display interesting links to its “fans.” The library’s Facebook page currently has more than 490 “fans. [Twitter](#) is an excellent way to communicate in a timely manner. The Library’s Twitter tool has been in use since June of 2009 and now has more than 1,900 followers. Both tools have seen increased use by library patrons and both have loyal and increasing numbers of followers.

UWS Publications Resulting from Recent WRI Groundwater Research and Monitoring Program-Sponsored and Other WRI-funded Projects

Water Resources Institute Reports

Choi, W., and C. Wu. 2016. Impacts of climate and land use changes on streamflow and water quality in the Milwaukee River Basin. Final report, Water Resources Institute, University of Wisconsin-Madison. WR13R004.

Feriancikova, L., and S. Xu. 2013. Transport of manure-derived, tetracycline resistant *Escherichia coli* in unsaturated soil. Final report, Water Resources Institute, University of Wisconsin-Madison. WR11R007.

Ginder-Vogel, M., and C. Remucal. 2016. Effect of source chemistry on Mn-bearing solid dissolution and reactivity in municipal water systems. Final report, Water Resources Institute, University of Wisconsin-Madison. WR15R009.

Gorski, P., M. Shafer, J. Hurley, S. Zana, and J. Swarthout. 2015. Hexavalent chromium (Cr(VI)) in WI groundwater: identifying factors controlling the natural concentration and geochemical cycling in a diverse set of aquifers. Final report, Water Resources Institute, University of Wisconsin-Madison. WR12R005.

Grundl, T., L. Fields-Sommers, and J. Graham. 2016. Groundwater-surface water interactions caused by pumping from a riverbank inducement well field. Final report, Water Resources Institute, University of Wisconsin-Madison. WR13R002.

Hauxwell, J. 2016. Wisconsin Water Resources Fellowship. Final report, Water Resources Institute, University of Wisconsin-Madison. WR15R006.

Larson, E.R., and S.A. Allen. Establishing the long-term range of variability in drought conditions for southwest Wisconsin. Final report, Water Resources Institute, University of Wisconsin-Madison. WR13R003.

Larson, R., and M. Holly. 2015. Silage storage runoff water quality assessment and design recommendations to limit environmental impacts. Final report, Water Resources Institute, University of Wisconsin-Madison. WR11R007.

Li, Z. 2013. Influence of adsorbed antibiotics on water quality and soil microbes. Final report, Water Resources Institute, University of Wisconsin-Madison. WR10R006.

Loheide, S., and C.B. Voter. 2015. Effects of nuanced changes in lot layout and impervious area connectivity on urban recharge. Final report, Water Resources Institute, University of Wisconsin-Madison. WR12R002.

- Luczaj, J.A., M. Zorn, and J. Baeten. 2013. An evaluation of the distribution and sources of dissolved strontium in the groundwater of eastern Wisconsin, with a focus on Brown and Outagamie counties. Final report, Water Resources Institute, University of Wisconsin-Madison. WR12R004.
- McIntyre, P.B. 2016. Climate change impacts on stream temperature and flow: consequences for Great Lakes fish migrations. Final report, Water Resources Institute, University of Wisconsin-Madison. WR11R002.
- Potter, K. 2015. Quantifying and communicating uncertainty in products of the USGS National Water Census. Final report, Water Resources Institute, University of Wisconsin-Madison. WR14R005.
- Sellwood, S.M., D.J. Hart, M.B. Gotkowitz, and J.M. Bahr. 2015. Identifying the controls on flow and contaminant distribution in siliciclastic bedrock aquifer systems. Final report, Water Resources Institute, University of Wisconsin-Madison. WR12R001.
- Stelzer, R., T. Scott, and L. Bartsch. 2013. The effects of particulate organic carbon quantity and quality on denitrification of groundwater nitrate. Final report, Water Resources Institute, University of Wisconsin-Madison. WRI11R006.
- Thompson, A., K.G. Karthikeyan, R. Stenjem, D. Hyndman, A. Kendall, and A. Parish. 2015. Implications of climate change and biofuel development for Great Lakes regional water quality and quantity. Final report, Water Resources Institute, University of Wisconsin-Madison. WR10R008.
- Thompson, A., K.G. Karthikeyan, and R. Jackson. 2013. Groundwater recharge characteristics and subsurface nutrient dynamics under alternate biofuel cropping systems in Wisconsin. Final report, Water Resources Institute, University of Wisconsin-Madison. WR10R003.
- Ventura, S., and S. Cardiff. 2016. Advances in monitoring and analysis of trace metals: a workshop to address applications in the Upper Great Lakes. Final report, Water Resources Institute, University of Wisconsin-Madison. WR14R001.
- Wu, C. 2016. Uncertainty and variability of Wisconsin lakes in response to climate change. Final report, Water Resources Institute, University of Wisconsin-Madison. WR11R003.
- Xu, S., and L. Feriancikova. 2015. Transport of manure-derived *Escherichia coli* within naturally-fractured dolomite. Final report, Water Resources Institute, University of Wisconsin-Madison. WR12R003.

Theses

- Baeten, Joseph. 2013. Spatial distribution and source identification of dissolved strontium in eastern Wisconsin's aquifers. University of Wisconsin-Green Bay.
- Childress, Evan S. 2014. Cross-ecosystem delivery of nutrients to streams: the role of fish migrations and processes. Ph.D. Thesis. Freshwater and Marine Sciences, University of Wisconsin-Madison. 130 pp.
- Fields-Sommers, Laura. 2015. Assessing the Effects of Riverbank Inducement on a Shallow Aquifer in Southeastern Wisconsin. Masters Thesis. School of Freshwater Sciences, UW –Milwaukee. 211 pp.

Louison, Michael. 2013. Use of first-order tributaries by brown trout (*Salmo trutta*) as nursery habitat in a central Wisconsin coldwater stream network. M.S. Thesis. Department of Biology & Microbiology, University of Wisconsin-Oshkosh. 56 pp.

Polich, Michael. 2015. Surface runoff, soil, and nutrient fluxes of cellulosic biofuel cropping systems. M.S. Thesis, University of Wisconsin-Madison. 87 pp.

Sellwood, Stephen M. 2015. Characterization of groundwater flow in sandstone aquifers using heat as an in-well tracer. Ph.D. Thesis. Geoscience, University of Wisconsin-Madison. 122 pp.

Sijan, Zana. 2014. Novel approaches for assessment of factors influencing human health impacts of chemicals in the environment. M.S. Thesis. Environmental Chemistry and Technology, University of Wisconsin-Madison. 201 pp.

Sourbeer, John. 2013. Long term soil moisture monitoring and assessing theoretical data interpretation techniques using heated distributed temperature sensing. M.S. Thesis, Civil and Environmental Engineering, University of Wisconsin-Madison.

Stenjem, Ryan S. 2013. Subsurface water and nutrient dynamics of cellulosic biofuel cropping systems. M.S. Thesis. Biological Systems Engineering, University of Wisconsin, Madison, WI. 134pp.

Other Publications

Allen, S., and E.R. Larson. 2014. The Driftless Oaks: An environmental history of southwest Wisconsin. Wisconsin Natural Resources 38: 6–7. [available: <http://dnr.wi.gov/wnrmag/2014/10/Oak.htm>].

Arrington, K.E., S.J. Ventura, and J.M. Norman. 2013. Predicting saturated hydraulic conductivity for estimating maximum soil infiltration rates. Soil Science of America Journal 77:748-758. doi: 10.2136/sssaj2012.0288.

Bero, N.J., M.D. Ruark, and B. Lowery. 2014. Controlled-release fertilizer effect on potato and groundwater nitrogen in sandy soil. Agronomy, Soils & Environmental Quality 106:359-368. doi:10.2134/agronj2013.0331.

Chadwick, S.P., C.L. Babiarz, J.P. Hurley, D.E. Armstrong. 2013. Importance of hypolimnetic cycling in aging of “new” mercury in a northern temperate lake. Science of the Total Environment 448:176-188. doi:10.1016/j.scitotenv.2012.10.069.

Chang, P.-H., Z. Li, J.-S. Jean, W.-T. Jiang, Q. Wu, K.-H. Lin, and J. Kraus. 2014. Desorption of tetracycline from montmorillonite by aluminum, calcium and sodium: an indication of intercalation stability. International Journal of Environmental Science and Technology 11:633-644. doi:[10.1007/s13762-013-0215-2](https://doi.org/10.1007/s13762-013-0215-2).

Chang, P-H, Z. Li, W-T Jiang, C-Y Kuo, and J-S Jean. 2015. Adsorption of tetracycline on montmorillonite: influence of solution pH, temperature, and ionic strength. Desalination and Water Treatment 55:1380-1392. DOI:10.1080/19443994.2014.924881.

Childress E. and P.B. McIntyre. 2014. Multiple nutrient subsidy pathways from a spawning migration of iteroparous fish. Freshwater Biology 60: 490–499. doi:10.1111/fwb.12494.

Childress E., J.D. Allan, and P.B. McIntyre. 2014. Nutrient subsidies from iteroparous fish migrations can enhance stream productivity. Ecosystems 17:522-534. Doi: 10.1007/s10021-013-9739-z.

- Childress, E. and P.B. McIntyre. 2016. Life history traits modulate ecosystem-level effects of nutrient subsidies from fish migrations. *Ecosphere*, in press.
- Childress, E.S. and P.B. McIntyre. 2015. Multiple nutrient subsidy pathways from a migration of iteroparous fishes. *Freshwater Biology* 60: 490-499. doi: 10.1007/s10021-013-9739-z.
- Childress, E.S., R. Papke, and P.B. McIntyre. 2015. Spawning success and early life history of longnose suckers in Great Lakes tributaries. *Ecology of Freshwater Fish*. doi: 10.1111/eff.12220.
- Deng, Y. and C. Wu. 2016. Development of a class-based multiple endmember spectral mixture analysis (CMESMA) approach for analyzing urban environments. *Remote Sensing*, in press.
- Dunkle, K.M., M.P. Anderson, and D. Hart. 2015. New ways of using well construction reports for hydrostratigraphic analyses. *Groundwater*. DOI: 10.1111/gwat.12326.
- Grundl, T., N. Magnusson, M.S. Brennwald, and R. Kipfer. 2013. Mechanisms of subglacial groundwater recharge as derived from noble gas, ^{14}C , and stable isotopic data. *Earth and Planetary Science Letters* 367-370:78-85. <http://dx.doi.org/10.1016/j.epsl.2013.03.012>.
- Jiang, W.-T., C.-J Wang, Z. Li. 2013. Intercalation of ciprofloxacin accompanied by dehydration in rectorite. *Applied Clay Science* 74:74-80. <http://dx.doi.org/10.1016/j.clay.2012.07.009>
- Jiang, W.-T., Chang, P.-H. Wang, Y.-S., Tsai, Y., Jean, J.-S., Li, Z., Krukowski, K. 2013. Removal of ciprofloxacin from water by birnessite. *Journal of Hazardous Materials* 250-251:362-369. <http://dx.doi.org/10.1016/j.jhazmat.2013.02.015>
- Li, Z., C. Stockwell, J. Niles, S. Minegar, and H. Hong. 2013. Uptake of sulfadiazine sulfonamide from water by clinoptilolite. *Applied and Environmental Soil Science - Article ID 648697*, 8 pp. <http://dx.doi.org/10.1155/2013/648697>.
- Lv, G., C. Stockwell, J. Niles, S. Minegar, Z. Li, and W.-T. Jiang. 2013. Uptake and retention of amitriptyline by kaolinite. *Journal of Colloid and Interface Science* 411:198-203. <http://dx.doi.org/10.1016/j.jcis.2013.08.026>.
- Lv, G., C.W. Pearce, A. Gleason, L. Liao, M.P. MacWilliams, and Z. Li. 2013. Influence of montmorillonite on antimicrobial activity of tetracycline and ciprofloxacin. *Journal of Asian Earth Sciences* 77:281-286. [doi:10.1016/j.jseaes.2013.04.025](http://dx.doi.org/10.1016/j.jseaes.2013.04.025).
- Lv, G., L. Wu, Z. Li, L. Liao, and M. Liu. 2014. Binding sites of chlorpheniramine on 1:1 layered kaolinite from aqueous solution. *Journal of Colloid and Interface Science* 424:16-21. [doi:10.1016/j.jcis.2014.03.010](http://dx.doi.org/10.1016/j.jcis.2014.03.010).
- Lv, G., Z. Li, N. Hoepfner, L. Wu, and L. Liao. 2014. Interactions between sulfa drug sulfadiazine and hydrophobic talc surfaces. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 446:172-178. [doi:10.1016/j.colsurfa.2014.01.014](http://dx.doi.org/10.1016/j.colsurfa.2014.01.014)
- Lv, G., Z. Li, W.-T. Jiang, P.-H. Chang, and L. Liao. 2015. Interlayer configuration of ionic liquids in a Ca-montmorillonite as evidenced by FTIR, TG-DTG, and XRD analyses. *Materials Chemistry and Physics* 162:417-424. [doi:10.1016/j.matchemphys.2015.06.008](http://dx.doi.org/10.1016/j.matchemphys.2015.06.008).

- Lyons J, A.L. Rypel, P.W. Rasmussen, T.E. Burzynski, B.T. Eggold, J.T. Myers, T.J. Paoli, and P.B. McIntyre. 2015. Trends in the reproductive phenology of two Great Lakes fishes. *Transactions of the American Fisheries Society* 144:1263-1274. DOI:
- Magee, M. C.H. Wu, D.M. Robertson, R.C. Lathrop, and D.P. Hamilton. 2016. Trends and abrupt changes in 104-years of ice cover and water temperature in a dimictic lake in response to air temperature, wind speed, and water clarity drivers. *Hydrology and Earth System Sciences* 20:1681-1702. doi:10.5194/hess-2015-488.
- Masarik, K.C., J.M. Norman, K.R. Brye. 2014. Long-term drainage and nitrate leaching below well-drained continuous corn agroecosystems and a prairie. *Journal of Environmental Protection* 5:240-254. doi: [10.4236/jep.2014.54028](https://doi.org/10.4236/jep.2014.54028).
- McIntyre, P.B., C. Reidy Liermann, E. Childress, E.J. Hamann, S.R. Januchowski-Hartley, A.A. Koning, T.M. Neeson, D.L. Oele, and B.M. Pracheil. 2016. Conservation of migratory fishes in freshwater ecosystems. Pp. 324-360. In: Closs, G.P., M. Krkosek, and J.D. Olden (eds.): *Conservation of Freshwater Fishes*. Cambridge University Press. Cambridge, United Kingdom.
- Melching, C.S., J. Liang, L. Fleer, and D. Wethington. 2015. Modeling the water quality impacts of the separation of the Great Lakes and Mississippi River basins for invasive species control. *Journal of Great Lakes Research* 41:87-98. doi:[10.1016/j.jglr.2014.11.009](https://doi.org/10.1016/j.jglr.2014.11.009).
- Sellwood, S.M., D.J. Hart, and J.M. Bahr. 2015. Evaluating the use of in-well heat tracer tests to measure borehole flow rates. *Groundwater Monitoring & Remediation* 35:85-94. DOI:10.1111/gwmr.12134.
- Stelzer, R.S., J.T. Scott, and L.A. Bartsch. 2015. Buried particulate organic carbon stimulates denitrification and nitrate retention in stream sediments at the groundwater-surface water interface. *Freshwater Science* 34:161-171. DOI: [10.1086/678249](https://doi.org/10.1086/678249).
- Stelzer, R.S., J.T. Scott, L.A. Bartsch, and T. B. Parr. 2014. Particulate organic matter quality influences nitrate retention and denitrification in stream sediments: evidence from a carbon burial experiment. *Biogeochemistry* 119:387-402. DOI 10.1007/s10533-014-9975-0
- Wu, Q., Z. Li, and H. Hong. 2013. Adsorption of the quinolone antibiotic nalidixic acid onto montmorillonite and kaolinite. *Applied Clay Science* 74:66-73. doi:[10.1016/j.clay.2012.09.026](https://doi.org/10.1016/j.clay.2012.09.026).
- Wu, Q., Z. Li, H. Hong, R. Li, and W.-T. Jiang. 2013. Desorption of ciprofloxacin from clay mineral surfaces. *Water Research* 47:259-268. <http://dx.doi.org/10.1016/j.watres.2012.10.010om>.
- Xing, X. P.-H. Change, G. Lv, W.-T. Jiang, J.-S. Jean, L. Liao, and Z. Li. 2015. Ionic-liquid-crafted zeolite for the removal of anionic dye methyl orange. *Journal of the Taiwan Institute of Chemical Engineers* 59:237-243. doi:[10.1016/j.jtice.2015.07.026](https://doi.org/10.1016/j.jtice.2015.07.026).

For more information on the WRI:

Visit the WRI website (wri.wisc.edu)

Contact Dr. Jennifer Hauxwell, Assistant Director for Research and Student Engagement of the University of Wisconsin Water Resources Institute

1975 Willow Drive**Madison, WI 53706****Phone (608) 262-0905, fax (608) 262-0591, email jennifer.hauxwell@aqua.wisc.edu****UW-Extension's Central Wisconsin Groundwater Center**

The Central Wisconsin Groundwater Center provides groundwater education, research, and technical assistance to the citizens and governments of Wisconsin. Assistance includes answering citizen questions, helping communities with groundwater protection, describing the extent and causes of groundwater pollution, assessing drinking water quality, and working on groundwater policy. Recent policy work focuses on groundwater pumping and impacts on surface waters. The center is part of the Center for Watershed Science and Education, an office of UW-Extension Cooperative Extension Service, and the UW-Stevens Point College of Natural Resources. More information can be found at

<http://www.uwsp.edu/cnr-ap/watershed/>.

Well Water Testing

In calendar year 2015, the Center assisted 3,516 households in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and Environmental Analysis Laboratory. Fourteen Drinking Water Education Programs helped 1,409 well users in 13 counties understand potential remedies for these problems and the relationship of land-use practices to groundwater quality. Nitrate screening and information on well water testing was provided at Wisconsin Farm Technology Days.

Water Quality Database

The Groundwater Center maintains a database of private well testing data from the Water and Environmental Analysis Regional Laboratory at UW-Stevens Point, and drinking water education programs conducted through the Center. There are currently 742,085 individual test results for approximately 89,278 samples covering the state, including 25 counties with 100 to 500 samples and 37 counties with 500 or more samples. Chemistry data includes pH, conductivity, alkalinity, total hardness, nitrate-nitrogen, chloride, saturation index, and coliform bacteria. The database primarily covers the period 1985 to the present. The database is PC-based and can be easily queried to be a significant source of information for local communities and groundwater managers.

Interactive Wisconsin Well Water Quality Viewer

In July 2012, the Groundwater Center made publically available an online mapping tool that allows people to search for groundwater quality information. The tool incorporates private well water data from the Center's database, the Wisconsin Department of Natural Resources (DNR) Groundwater Retrieval Network, and the Department of Agriculture, Trade and Consumer Protection. In 2014, data from the Eau Claire County Health Department was also integrated. [Summary maps](#) are available for 14 different water quality parameters and can be viewed or summarized into a table at a county, town, or section level detail. In 2015, nearly 7,000 people used the viewer. The next update for the viewer is scheduled to be completed by 2017; data from additional county health departments will be included in the update.

Central Wisconsin county-based volunteer streamflow monitoring

In a joint project with five county conservation offices and DNR, the Center launched a program that provides citizen volunteers with professional grade streamflow monitoring equipment. This is part of an effort to better understand water conditions in the pumping stressed region of the central sands. Staff has worked with county staff to recruit and train volunteers. Currently, staff are coordinating with 10 citizen volunteers to measure baseflow at 70 sites throughout the Central Sands region. A quality/control procedure is in place by Center staff to independently verify a percentage of each citizen volunteer's measurements to ensure consistency and accuracy; results are extremely encouraging. These volunteers fill a large gap in the ability to collect baseline monitoring data of stream flow in the Central Sands region.



The Little Plover River, one of the many streams in the pumping stressed region of the Central Sands.
Photo: UW WRI.

Chemical Tracers for Identifying Sources of Groundwater Nitrate-Nitrogen

Chemical analysis methods for a suite of human wastewater tracers and agricultural pesticide metabolites were developed and then used to analyze water from a group of private wells with elevated nitrate concentrations. This study will assist in identifying compounds useful for tracking sources of nitrate contamination and increase our understanding of the occurrence of these “emerging” compounds in private drinking water. Center staff worked with the DNR and the Wisconsin Department of Health Services to develop drinking water advisory levels for some of the compounds detected. Results from this study have been presented at the Wisconsin American Water Resources Association meeting and the American Geophysical Union Annual Meeting.

Groundwater Phosphorus

Phosphorus analysis of groundwater collected through water education programs has been used to better understand the distribution, concentration, and sources of groundwater phosphorus in Wisconsin. This is one of the largest sources of groundwater phosphorus information available in the state and helps fill an important gap in understanding the sources of phosphorus to surface water resources. Results have been presented at several Wisconsin meetings and workshops and are being summarized in a scientific publication which is under review.

Chippewa County Groundwater Quality Inventory

The Center was contracted by the Chippewa County Land Conservation and Forest Management Department to collect and analyze samples from 800 private wells from around the county. The county has previously conducted inventories in 1985 and 2007 for nitrate and chloride. Results from samples collected in the summer of 2016 will be compared with previous results to better understand how groundwater quality may have changed through that time. Nitrate source analysis will be performed on a subset of wells to better understand sources of elevated nitrate levels in Chippewa County.

Policy

The Center continues to play pivotal roles in a number of state groundwater issues. Working with partners in the private and public sectors on groundwater quantity policy and law has been a continuing priority for the Center. Director George Kraft has been called upon to provide testimony to legislative

committees related to groundwater quantity issues and routinely presents to local and state government officials on the science of groundwater pumping and associated impacts. Research Scientist Paul McGinley participated in a recent DNR workshop on estimating groundwater phosphorus loads to surface waters.

Partnerships

The Center continues to work closely with state agencies, local governments, land conservation departments, UW-Extension county faculty and natural resource educators, and many local watershed-based groups.

Recent Publications and Reports

McGinley, P.M., K.C. Masarik, M.B. Gotkowitz and D.J. Mechenich. Impact of Anthropogenic Geochemical Change and Aquifer Geology on Groundwater Phosphorus Concentrations. *Applied Geochemistry* (In Review).

Luczaj, J., K. Masarik. 2015. Groundwater Quantity and Quality Issues in a Water-Rich Region: Examples from Wisconsin, USA. *Resources* 2015 4:323-357. doi:[10.3390/resources4020323](https://doi.org/10.3390/resources4020323)

Kraft, G.J., D.J. Mechenich, and J. Haucke. 2014. Information support for groundwater management in the Wisconsin central sands, 2011-2013. Report to the Wisconsin Department of Natural Resources. Center for Watershed Science and Education, University of Wisconsin – Stevens Point / Extension. http://www.uwsp.edu/cnr-ap/watershed/Documents/kraft_cs_2011_2013.pdf

Masarik, K., Norman, J. and Brye, and K. 2014. Long-Term Drainage and Nitrate Leaching below Well-Drained Continuous Corn Agroecosystems and a Prairie. *Journal of Environmental Protection* 5:240-254. doi: [10.4236/jep.2014.54028](https://doi.org/10.4236/jep.2014.54028).

Kraft, G.J., D.J. Mechenich, K. Clancy, and J. Haucke. 2012. Information Support for Groundwater Management in the Wisconsin Central Sands, 2009-2011. A Report to the Wisconsin Department of Natural Resources, Project NMA00000253.

Kraft, G.J., D.J. Mechenich, K. Clancy, and J. Haucke. 2012. Irrigation effects in the northern lake states – Wisconsin central sands revisited. *Ground Water Journal* 50:308-318. DOI: 10.1111/j.1745-6584.2011.00836.x

For more information on the UW-Extension's Central Wisconsin Groundwater Center:

Contact George Kraft, Center for Watershed Science and Education

College of Natural Resources, UW-Stevens Point

Stevens Point, WI 54481

Phone (715) 346-4270, email gndwater@uwsp.edu

UW Environmental Resources Center (ERC)

The UW Environmental Resources Center ([ERC](#)) hosts UW-Extension (UWEX) state specialists addressing water resources, land and water conservation, forestry, conservation professional training,

citizen engagement, and volunteer monitoring. ERC also coordinates a number of regional and national programs addressing water resources and water-education initiatives related to groundwater.

ERC Regional Water Programs and Conservation Professional Development

As a successor to the 12-year [Great Lakes Regional Water Program](#), ERC hosts the [North Central Regional Water Network \(NCRWN\)](#), a 12-state collaboration among Land Grant universities including partnerships with state and federal agencies across the Upper Midwest region. Through this network, Extension researchers and educators share programs and coordinate for an array of water resource issues, including groundwater quantity and quality.

One of the programs emerging from ERC regional collaboration is a partnership providing multi-state professional development to conservation professionals (<http://conservation-training.wisc.edu/>). Wisconsin programs have included issues of conservation lands management such as manure management and fractured bedrock geology, including:

- Training public- and private-sector professionals to help farmers more effectively manage manure and commercial nitrogen fertilizers that can negatively impact groundwater
- Training for manure applicators on manure application in karst areas
- Providing conservation planning training and farmer training that includes karst issues
- Projects that help water resource managers understand farmer awareness of, and capacity to adopt, conservation practices that are most likely to fit into farm management systems
- The [Conservation Reserve Program Readiness Initiative](#), a national program to train public- and private-sector professionals to assist with implementation of the Conservation Reserve Program, which protects water resources while compensating farmers for taking marginal land out of production

ERC Water Outreach and Education

The [Water Action Volunteers](#) Stream Monitoring Program educates both children and adults about stream ecology and stream health. Volunteers continue to monitor over 500 stream sites statewide for a variety of parameters, including stream flow, which is directly affected by groundwater. Volunteer-collected data is helping to characterize water quality and quantity across the state and to identify streams where impairments may exist.

In recent years, a curriculum targeted to middle- and high-school students called *Exploring Streams* was completed. Over 70 Wisconsin teachers have been trained to use it in their classrooms, more than doubling the number of teachers in the state educating students about connections between land use and water quality and quantity.

The [Wisconsin Master Naturalist](#) program was piloted in 2012 and fully launched in spring 2013. The program follows a train-the-trainer approach. The course curriculum covers a variety of natural resources issues specific to Wisconsin, including groundwater quality and use. Certified volunteers are expected to provide 40 hours of natural resource-related service annually to Wisconsin host organizations, such as nature centers, state parks, or museums. Areas of service include: education/interpretation, stewardship, and citizen science. This program continues to grow in cooperation with partners across Wisconsin.

Other projects include the National Extension Water Outreach Education project to develop and promote best education practices for water education and to improve access to education resources and strategies. Involvement with the national youth water initiatives, [Give Water a Hand](#), Water Equals, and [Educating Young People about Water](#), continues, and those programs formed the basis for a new [Thinkwater](#) initiative through the UWEX Program Development and Evaluation unit. Find links to these programs on the ERC website at <http://www.uwex.edu/erc>.

UWEX's Regional Natural Resources Program

The University of Wisconsin System cooperates on community-focused educational programs with other state agencies involved with water resources and natural resource issues. Since 1998, UWEX has worked in partnership to support state, county, and local efforts to protect and improve surface and ground water quality and quantity across the state. Locally situated natural resource educators develop and conduct programs that reach local and statewide audiences, accessing state-level support for educational material development and program evaluation. The educational programs address a broad range of groundwater-related topics, including drinking water, threats to groundwater quality, impacts of land-use changes and land management decisions on groundwater quantity, information about localized groundwater problems such as karst geology, water conservation and efficiency, along with a variety of other issues associated with nutrients in surface water and groundwater.

More information on the Regional Natural Resources Program can be found <http://naturalresources.uwex.edu>.

For more information on UW ERC programs related to groundwater:

Contact Ken Genskow, UW Environmental Resources Center

445 Henry Mall, Room 202

Madison, WI 53706

Phone (608) 262-0020, fax (608) 262-2031, email kgenskow@wisc.edu

UW Nutrient and Pest Management (NPM) Program

Mission Statement:

Wisconsin's Nutrient and Pest Management (NPM) Program works with a wide range of partners to promote agricultural practices for protecting water quality while maintaining or improving farm profitability. The University of Wisconsin NPM Program serves Wisconsin farmers and the agricultural professionals who assist them in making management decisions. The program links farmers and researchers to exchange knowledge on the profitability, practicality, and environmental impact of crop production practices and cropping systems.

Nutrient Management:

The NPM Program is part of a team that develops, distributes, evaluates, and implements nutrient management education programs. Partners include: University of Wisconsin-Madison College of Agriculture and Life Sciences (UW-CALS) faculty/staff, county-based UW-Extension, land conservation departments, Wisconsin technical colleges, the Wisconsin Department of Agriculture, Trade and

Consumer Protection, U.S. Department of Agriculture-Natural Resources Conservation Service, along with private-sector agri-businesses and Wisconsin farm producers. Activities include:

- *Nutrient Management Farmer Education Curriculum* development and implementation. Cumulative accomplishments numbers from 2000 to 2015 show that as a result of local delivery of the curriculum, over 6,234 producers farming approximately 1,781,920 acres in 55 counties have received in-depth education on nutrient management planning. In 2015, approximately 874 farmers operating about 227,530 acres in over 30 Wisconsin counties added to this accomplishment list. Data currently being collected for 2016 accomplishments.
- *SnapPlus nutrient management planning software* assistance and refinement in conjunction with the SnapPlus team (UW-Soil Science). NPM staff assist in developing educational tutorial online videos (30 total), updating the SnapPlus online help system, refining output reports to meet the needs of end users, creation of a SnapPlus training manual with over 350 copies requested and delivered.
- *Managing Nutrients on Wisconsin Soils (MNWS)* was an intensive self-paced, seven-hour online video series designed for agency and agriculture industry personnel who desired to gain more knowledge of intermediate to advanced topics in soil fertility and management. The learning objectives were to provide individuals with fundamental understandings of Wisconsin's nutrient application guidelines, advanced soil fertility management tools, and soil management practices to reduce nutrient loss. This workshop was delivered to clients via an online video technique. Use of this delivery mechanism was in response to client concerns regarding costs associated with traditional (face-to-face) workshops. Travel, lodging, meal, hard copy, etc. expenses were greatly reduced or eliminated with this approach.
- *Training for Nutrient Management Planners (TNMP)* was a self-paced seven hour online video series and a one day face-to-face, follow-up workshop. The program is designed for current and potential nutrient management plan writers in Wisconsin - particularly production agronomists and county-based conservation staff. The intent of this workshop is to provide in-depth training on the preparation of quality nutrient management plans.
- *Spring Green-area Nitrogen Management*: In response to degradation of public and private drinking water resources due to nitrate, NPM working with a team of county UW-Extension and UW soil scientists has surveyed farmers in the area on their N management practices. As a follow-up, a series of on-farm demonstrations featuring various N management practices have occurred in the area. Practices features initially include: manure application timing (with and w/o Instinct), irrigation management, and UW recommended nitrogen rates for corn on sands.
- Educational support to numerous Wisconsin watershed projects. Activities include coordination and delivery of individual nutrient management plans, phosphorus index model calibration and ground-truthing, manure spreader calibrations. Also, key member of the Farmer-led, performance-based watershed project in Barron, Polk, St. Croix, Pierce and Dunn Counties. The latter project serves as a prototype for managing TMDL watersheds across Wisconsin.
- On-farm demonstrations, field plot research, and subsequent educational programs on various topics (corn N rates, cover crops, conservation tillage, manure treatments, etc.) at various locations across Wisconsin.

Pest Management:

NPM in conjunction with numerous partners, including UW-CALS faculty/staff, county-based UW-Extension, UW Integrated Pest Management (IPM) Program, Wisconsin Agri-Business Association, and others, delivers timely educational programming on topics associated with pest management. Activities include:

- *The Continuing Custom Applicator Program* which develops and delivers an annual educational program for increasing the professionalism of custom pesticide applicators by broadening their knowledge of the products they use, available new technologies, and customer service.
- *Managing Volunteer Winter Wheat in Summer Alfalfa (RR) Seedings*: NPM, in conjunction with the UW-Madison CALS Dept. of Agronomy (Dr. Mark Renz) is investigating the control of volunteer wheat in summer seeded Roundup Ready alfalfa. Three locations: Grant, Sheboygan, and Columbia Counties. The objective is to compare and contrast the timing of Round Up, Raptor, and Post-Plus on the control of volunteer winter wheat.
- *Profitability of Alternative Management Strategies for Western Corn Rootworm*: A series of large-scale, on-farm demonstrations and management comparisons of various strategies for controlling corn rootworm. At each site, the profitability of alternate management practices versus the standard practice of relying solely on Bt corn varieties is made.

Food Systems:

- *Cover Crops Research, Education, and Outreach* activities include development and instruction of cover crop demonstration and training. Also fielding inquires and providing advice on cover crop selection and management. This includes recommendations of cover crop species, planting dates and seeding rates to match the planting window and supplemental forage and soil conservation needs. Activities include a demonstration plot at the 2015 Farm Tech Days site featuring 16 cover crop options, and on-farm demonstrations & research cover crop trials in Sheboygan, Dane, Pierce, Polk, and Dunn Counties.
- *Frac Sand Mining Site Reclamation*: 2015 marks the second year of a frac sand mining reclamation site restoration project. This project, located in Chippewa County, is in cooperation with the county Land Conservation Dept., UW-River Falls, and the mining company. The intent is to investigate the remediation of mining sites to agricultural land use. This year's site converted to pasture. Plans for next year call for a conversion to corn production on a new site.
- *Healthy Grown / Health Farms*: The Healthy Grown – which was expanded to the Healthy Farm - program has been a national model of sustainable production systems, exemplifying integrated pest management and reduced pesticide systems for potato production. There is also an innovative ecosystem conservation component to restore privately owned landscaped in Wisconsin. Utilizing the Healthy Farm concept, additional commodities are developing sustainability standards. NPM staff are involved in efforts for pea, sweet corn, and soybean.

Outreach and Communication:

- *Mobile Applications*: The NPM Program is creating mobile applications (apps) for hand-held devices. Six apps are currently available: Nitrogen (N) price calculator, Corn N rate calculator, Integrated Pest Management toolkit, Corn crop calculators, Manure and legume nutrient credit

calculator, and a Soybean replanting decision aid. Collectively, these apps have been downloaded by over 10,000 users from every continent except Antarctica.

- *YouTube Videos*: Dozens of YouTube educational videos featuring UW-CALS specialists have been prepared and released by the NPM and IPM programs over the past four years. A complete listing can be found at <http://www.youtube.com/uwipm>. A conservative estimate of the number of views is greater than 80,000.
- *Wisconsin Crop Manager Newsletter and IPCM Website*: The NPM and IPM Program website delivers the popular *Wisconsin Crop Manager* newsletter featuring contributions from faculty and staff across UW-CALS departments. *Wisconsin Crop Manager* is produced weekly during the growing season with semi-monthly and monthly releases during the winter months. This website averages over 400 users per day with 2,500 regular, repeat viewers.
- *NPM Publications*: The NPM Program has a long history of publishing timely, pertinent, high-quality publications on the topics of improved agricultural management practices. Formats have ranged from simple pocket-sized cards to extensive manuals and workbooks. A listing of NPM's print publications can be found at: <http://ipcm.wisc.edu/downloads/>

For more information on the NPM program:

Visit the website (<http://ipcm.wisc.edu>)

Contact Scott Sturgul, Wisconsin NPM Program

445 Henry Mall, Room 314

Madison, WI 53706

Phone (608) 262-7486, email ssturgul@wisc.edu

Wisconsin State Laboratory of Hygiene

At the Wisconsin State Laboratory of Hygiene (WSLH), a great deal of effort is focused on identifying and monitoring chemical and microbial contaminants in groundwater through testing, emergency response, education and outreach, and specialized research. The activities related to groundwater span several departments at WSLH. The mission of the WSLH is to protect the health of drinking water consumers by providing analytical expertise, research, and educational services to the scientific and regulatory communities and the public.

The chemical and microbial groundwater contaminants routinely tested include all contaminants regulated by the federal Safe Drinking Water Act, as well as many emerging contaminants that appear on the USEPA Contaminant Candidate List. Examples include: fecal indicators (total coliform, *E. coli*, coliphage, *Bacteroides* spp., *Rhodococcus coprophilus*, Sorbitol-Fermenting Bifidobacteria), *E. coli* O157:H7, toxigenic *E. coli*, *Salmonella*, waterborne viruses (Norovirus), human-adenovirus, parasites (*Cryptosporidium*, *Giardia*, and microsporidia), radioactivity, inorganic compounds (mercury, nitrate, arsenic), and organic compounds (atrazine, PCBs, PBDEs). The Water Microbiology section currently has molecular capabilities to analyze for human adenovirus and distinguish between bovine and human *Bacteroides* spp. as part of the laboratory's toolbox approach to microbial source tracking in groundwater.

In addition to routine testing of fecal indicators and emerging contaminants, the WSLH now employs a “toolbox” of microbial and chemical source-tracking assays. Microbial and chemical source tracking is used to determine sources of fecal contamination in water, whether from human or animal sources, using multiple microbial and chemical agents. The data is then used for making management decisions regarding control of fecal pollution of groundwater (see Wisconsin Department of Natural Resources (DNR) Activities).

Another important focus of the WSLH is emergency response to incidents involving groundwater. For example, WSLH works with Department of Health Services and DNR to investigate outbreaks of illnesses of unknown (possibly food or water) origin. Staff provides background information on the outbreaks for local public health officials, local media, and the general public. WSLH also responds to spills and incidents and supports state agencies in remediation and emergency cleanup activities.

WSLH also provides educational and outreach activities related to groundwater and drinking water including, (1) instructional consultations for well owners and well drillers, (2) assistance and consultation for municipal water supply operators, and (3) tours for a variety of international, educational, regulatory, and governmental groups. Staff members have developed publications related to drinking water including a well water activity sheet, “*Test your well water annually*” brochure, and other well water testing promotional materials. Staff members present papers at a variety of conferences and symposia and publish research findings in professional journals.

Summary of Groundwater-Related Work at WSLH

Organic Chemistry Section

- Interpretation of GC-MS analysis of sterols as a chemical source tracking indicator. Sterols are the excreted metabolites of hormones (i.e. - plant and animal) that are ingested by animals or metabolized from endogenous sources (i.e. - human synthesis and metabolism of cholesterol). Depending upon the sterol detected, and in what quantity, determinations may be inferred as to the type of source responsible. For example, a high level of coprostanol, relative to background, indicates anthropogenic contamination of a surface water sample. Detection of cholesterol along with plant sterols, such as beta-sitosterol and stigmasterol, would be indicative of fecal contamination by animals utilizing a mixed diet. Detection of the plant sterols alone would possibly occur with herbivore fecal contamination. Sterol source tracking data should correlate to orthogonal methodologies, such as the microbial source tracking protocols, in making a final determination.
- Analysis of pharmaceuticals and personal care products and antibiotics as tools to indicate pollution from humans and animals. This analysis in conjunction with the Microbial Source Tracking “Toolbox” is used to support the 2005 Wisconsin Act 123 Well Compensation Act Amendment (Compensation for Bacterial Contamination of Wells).

Chemical Terrorism and Preparedness Section

- The WSLH serves as the only public health emergency preparedness-supported chemical response laboratory in Wisconsin. The lab has extensive capabilities for testing human exposures to priority chemical threat agents provides sampling materials and guidance for first responders including hazardous material, drinking water, and natural resource entities, and performs any needed testing of environmental samples related to chemical incidents. One facet of this support

has been the development of a drinking-water collection kit, tailored to allow appropriate collection for assessing a wide range of chemical and microbiological contaminants in drinking water. These kits have been provided to all drinking water utilities serving over 3,000 people, as well as to public health and other appropriate agencies.

Water Microbiology Section

- “Source Assessment Requirement under the Revised Total Coliform Rule” WSLH has a grant from the US EPA and GCC to develop and implement a scientifically-based well assessment for wells testing positive for coliforms. This project is to develop and test a suite of microbial organisms that can determine the source of contamination by collecting a large volume sample using a hollow fiber ultra-filtration system.
- WSLH is researching changes to the fecal source tracking toolbox by implementing species-specific PCR assays for human, bovine, swine, and poultry Bifidobacteria; improving the PCR primer sets for human and bovine *Bacteroides* spp.; and determining the feasibility of using pepper mild mottle virus to determine human contamination in groundwater. The research includes collecting fecal samples from animals throughout the state to determine sensitivity and cross reactivity for microbial sources of contamination.
- As a part of a larger laboratory-wide preparedness program, WSLH is prepared to offer appropriate microbial water quality testing when disaster strikes. WSLH is a member of the Environmental Response Laboratory Network and the Water Laboratory Alliance for both chemical and biological response. This involves participation in nationwide preparedness drills coordinated by the Centers for Disease Control and Prevention in conjunction with the U.S. Environmental Protection Agency.
- The WSLH Flow Cytometry unit coordinates and distributes samples for the only *Cryptosporidium* Proficiency Testing Program (PT) available in the United States. This WSLH Program supports environmental laboratories testing water samples for the presence of this parasitic protozoan under the Long Term 2 Enhanced Surface Water Treatment Rule. The Program has been designed to provide water testing laboratories and accreditation agencies with a means of assessing a laboratory's performance of U.S. EPA Method 1622/1623. The Program is accredited under ISO 17043 "General Requirements for Proficiency Testing" by ACLASS and distributes samples twice annually. The Program operates with support from the WSLH Water Microbiology department which evaluates the robustness of the parasites suspensions prior to and following distribution to participant laboratories.
- The Water Microbiology section of the WSLH Environmental Health Division is currently performing work to evaluate the organisms used for the national PT. This work involves the prescreen assessment of the organisms used for proficiency testing as well as the stability of the organisms on the last day before expiration of *Cryptosporidium* spike used in the biannual PT events.

Inorganic Chemistry Section

- A variety of nutrients are routinely measured in drinking water, surface water, and groundwater. Those with health concerns in drinking water, such as nitrates are submitted by the public and well drillers and results are sent to the clients and the DNR for their database. The DHS has

worked with WSLH to provide drinking water kits available to newborn mothers at the county level to monitor for nitrates in well water.

- Most types of metals are also measured. Those of health concern, such as arsenic have become important in monitoring since they have been associated with specific geological formations and conditions in northeastern Wisconsin. For further study, the lab also has separated arsenic into its oxidation states and measured their relative concentrations. Detectable concentrations of arsenic have been more routinely measured in drinking water sourced from Wisconsin groundwater. Recent updates to Wisconsin regulations has increased monitoring requirements under certain scenarios. Arsenic in groundwater and drinking water has received increased attention in general.
- Ancillary inorganic tests are routinely performed such as chloride, sulfate, pH, alkalinity and conductivity that are important in controlling the chemical conditions for groundwater systems.
- As with other sections of the WSLH, the inorganic section responds to both spills that would affect both surface water and groundwater. The lab has worked extensively with both DNR and DHS to identify contaminants in well water that may have had surficial origins. The WSLH recently has added multi-collector ICPMS instrumentation that can be used to measure isotopic fingerprints of metals to source-track their origin.
- The inorganic section has a dedicated trace-level clean lab that routinely measures metals or elements in water at the parts per trillion (ppt) ranges for unique applied low-level research questions and monitoring.
- The WSLH also works with and receives samples from the U.S. Geological Survey, researchers at UW campuses, the Wisconsin Geological and Natural History Survey on specialized groundwater projects. The lab also routinely measures samples from drinking water utilities that rely on groundwater.

For more information on the WSLH:

Visit the website (<http://www.slh.wisc.edu/>)

Contact David Webb, Deputy Director, Wisconsin State Laboratory of Hygiene

2601 Agriculture Drive

Madison, WI 53718

Phone (608) 224-6200, email David.Webb@slh.wisc.edu